

SQLIntersection POSTCON02

Windows Azure SQL Database From A To Z

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About Bob Beauchemin

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- **Author of books and numerous resources related to SQL Server and data access**
 - Microsoft SQL Server 2012 Internals (special indexes chapter)
 - SQL Server MVP Deep Dives – Volume 1
 - A Developer's Guide to SQL Server 2005
 - A First Look at SQL Server 2005 for Developers
 - Essential ADO.NET



The Landscape

- **WASD released Feb 1, 2010**
- **Service Updates – Every few months**
 - Last one in Feb 2014
 - Service Updates announced on Windows Azure Blog
 - <http://blogs.msdn.com/b/windowsazure/>
- **WASD Wiki Articles**
 - <http://social.technet.microsoft.com/wiki/contents/articles/2267.windows-azure-sql-database-technet-wiki-articles-index-en-us.aspx>
- **Samples**
 - Available after the workshop



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SQL Server Configurations

- **There are four main ways SQL Server runs**
 - SQL Server on hardware
 - SQL Server virtualized on premises
 - SQL Server on cloud VM (IaaS)
 - Windows Azure SQL Database (PaaS)
- **Three main differences**
 - Resource Capacity
 - Latency
 - Hardware
 - WASD and Virtual - problems cannot be solved with hardware
 - Instead solve problems with programming, scale out, queuing



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Windows Azure SQL Database

- **Three reasons to run on Windows Azure SQL Database**
 - Elasticity
 - Low Management Overhead
 - Price
- **Don't directly compare SQL Server and WASD**
 - Decide what level of performance is needed
 - Use minimal repeatable examples for issues
 - Log your results
 - Don't measure average, measure percentile (50,95,99th)



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What You Don't Have to Do

- **With Windows Azure SQL Database, there's no**
 - Choosing hardware
 - Series of discrete sizes including premium edition
 - Installing SQL Server
 - Maintaining SQL Server and OS
 - Choosing SQL Server Version and Edition
 - Buying SQL Server Licenses
 - All database and instance configuration choices
 - Many/Most DBA configuration tasks



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M1: Setup And Administration

- Database overview and internal design
- Security and Management
- Supported DDL and Supported DML
- Troubleshooting and Tracking



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M2: Developing Applications

- Connecting to the database
 - Supported APIs
 - Keeping your connection alive
 - Connection retry on failure
- Dealing with resource throttling
 - Decoding Reason Codes
- T-SQL Differences
- Handling Transactions
- Federations



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M3: Deployment and Sync

- **Provisioning and Import-Export**
 - Scripts
 - BCP
 - SSIS
 - SQL Azure Migration Wizard
- **Development and Deployment using DACPAC**
- **Synchronization**
 - Windows Azure SQL Data Sync
 - Sync Framework SDK



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Questions?



Don't forget to complete an online evaluation on EventBoard!

Session: POSTCON02

Windows Azure SQL Database From A To Z

Your evaluation helps organizers build better conferences,
and helps speakers improve their sessions.



Thank you!

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Windows Azure SQL Database From A To Z Setup And Administration

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Overview

- Database overview and internal design
- Security and Management
- Supported DDL and Supported DML
- Troubleshooting and Tracking



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Windows Azure SQL Database

- **A cloud-based version of SQL Server**
 - Based on clustered SQL Servers
 - Abstraction layer for connections
 - Servers are load balanced
 - Databases are replicated
- **Provides**
 - High availability
 - Scalability
 - Reliability and security
 - Ease in provisioning
- **Works well with the Windows Azure Services**
 - Or combined with on-premises



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SLAs

- **Availability goal is 99.9%**
- **No performance guarantee yet**
 - Resource guarantee with Premium Database
- **No security SLA yet**



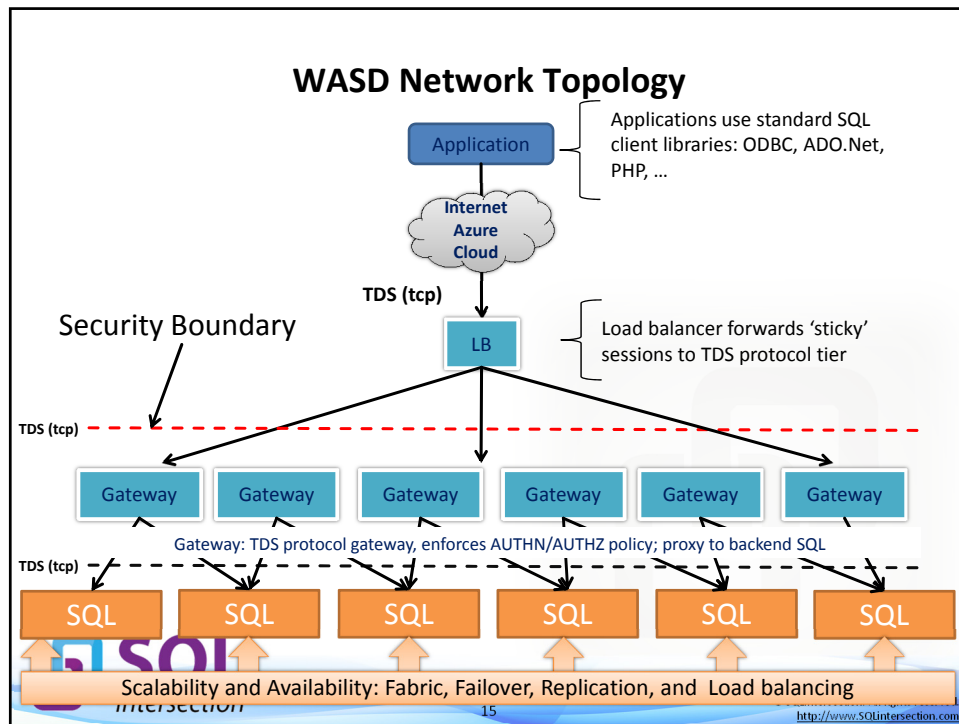
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Internal Database Design

- **Each user database is replicated three times**
 - One primary replica, two secondaries
 - Replica promotion happens during failover
- **Every commit is quorum commit**
 - Primary replica and one secondary replica
- **Primary replicas not on same server**
 - Must choose database to connect to
 - USE statement not permitted
- **Reads and writes all go through primary replica**

Setup

- **Obtain Windows Azure Account**
- **Create a WASD Database**
 - On portal or through Admin API
 - Can create multiple servers per subscription
 - Server can be specified or new
 - If server already exists, you can use DDL
- **Provision logins, users, data**
 - Multiple admin users per account permitted
- **For a new user, WASD owners need to add**
 - Login
 - Firewall entry for IP addresses (or address range)



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Database as a Linked Resource

- **Linked resource specifies that a database "belongs to" an application**
 - Web Site
 - Cloud Service
- **Databases can be created at other places in the portal**
 - Or added later as linked resources
- **A database specified as a linked resource**
 - Can be scaled along with associated application
 - Affects appsettings file used for application deployment
- **Does not provide automatic database connectivity**
 - Connection strings must still be used



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Administration

- **Windows Azure SQL Database can be administered with**
 - Windows Azure Portal
 - T-SQL
 - SSMS - Object Explorer and Template Explorer
 - Windows Azure PowerShell cmdlets
- **Not every option is available with each method**



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Database Management API

- **REST-based API**
 - Create, enumerate, drop servers
 - Reset admin password
 - Create, update, delete firewall rules
 - Manage databases and servers
- **PowerShell scripts available**
 - Part of Windows Azure Management Cmdlets
- **Uses mutual authentication with certificates**
 - You must provision a certificate



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Windows Azure PowerShell Cmdlets

- **Include cmdlets for Windows Azure SQL Database**
 - First setup your security and current subscription (if more than one)
 - Get-AzurePublishSettingsFile (gets publishsettings file)
 - Import-AzurePublishSettingsFile
 - Get-SqlAzureSubscription (also Set- and Select-)
 - Server management
 - Get-SqlAzureServer (also New- and Remove-)
 - Firewall management
 - Get-SqlAzureFirewallRules(also New- and Remove-)
 - Database management
 - Get-AzureSqlDatabaseServer (also New- Remove- and Set-)
- **Access through New-AzureSqlDatabaseServerContext**
 - Collections of database items
 - Server and Database metrics
 - DAC operations (see module 3)



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Topology - Owner Perspective

- **Each (logical) Server consists of**
 - Master Database
 - Similar in concept to SQL Server's Master
 - 0-N User Databases
 - User databases can be on different cloud nodes
 - Some tempdb functionality available
 - No MSDB or Model
 - User Databases Can Be
 - Web Edition - 1gb or 5gb
 - Business Edition - 10, 20, 30, 40, 50, or 150gb
 - Billing is based on usage - MAXSIZE can limit database size



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WASD Premium Database

- **WASD database has a series of resource limits**
- **Premium database feature (preview) provides resource reservations**
 - Geo-replication and point-in-time restore service available also

Reservation Size	CPU Cores	Worker Threads	Active Sessions	Disk IO (IOPS)	Memory (GB)
P1	1	200	2000	150	8
P2	2	400	4000	300	16



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Premium Database Management

- **Premium database can be set up through Portal or PowerShell cmdlets**
 - Can upgrade, downgrade, or switch premium reservation size
- **"CREATE DATABASE AS COPY OF" on a premium database**
 - Creates database as status "suspended premium"
 - Not billed as premium database
 - Can be upgraded to premium database if needed
- **Once it's set up**
 - Monitor status using `dbo.slo_database_objectives`
 - Display history of a single database using `dbo.slo_assignment_history`
 - Check activity using `sys.resource_stats`
- **Premium choices can be enumerated using other metadata views**



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Security

- **Firewall**
- **DOSGuard**
- **SQL Authentication**
- **Connection Encryption**
 - All connections encrypted



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WASD Firewall

- **WASD communicates through TDS**
 - Port 1433, not configurable
- **Connections managed by firewall rules**
 - Portal
 - Admin API (with IP Detect)
 - T-SQL system stored procedures
- **Track in SQL using sys.firewall_rules and sys.database_firewall_rules**
- **Need to register "external" IP address**
 - Error message provides IP to register
- **User needs to configure their firewall**
 - To allow traffic on port 1433



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Database-Level Firewall Rules

- **To setup database-level rules**
 - Connect to the database
 - Use `sp_set_database_firewall_rule`
 - Query through `sys.database_firewall_rules`
 - Delete with `sp_delete_database_firewall_rule`



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DOSGuard

- **Meant to prevent denial of service attacks**
- **Tracks IP addresses for connections**
 - If too many from one address/address range, further connections are disallowed for a while



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Logins and Roles

- **WASD Database uses SQL logins**
 - Strong password is required
 - No Windows login support
 - Login is user@server
- **Common login names unavailable**
 - sa, admin, administrator, root, and guest
- **No guest access to any database**
- **Server roles unavailable**
- **WASD-specific database roles in master**
 - dbmanager (can create DBs)
 - loginmanager (can create logins)



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Login Names and Applications

- **WASD server names are DNS names**
 - [servername].database.windows.net
 - Server names are assigned and cannot be changed
- **Most connection strings**
 - Server = <ServerDNSName>
 - UserID = <YourUsedID>
- **SQLCMD requires a slightly different syntax**
 - SQLCMD -U youruserid@foo -P {password} -S tcp:foo.database.windows.net -d yourdatabase



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Collations

- **Default database collation is SQL_LATIN1_GENERAL_CP1_CI_AS**
 - LATIN1_GENERAL is recommended for US
 - CP1 is code page 1252
 - CI is case-insensitive
 - AS is accent-sensitive
- **Can set collation per database at creation time**
 - Cannot change collation on existing database
- **Can set collation on**
 - Columns
 - Expressions
 - Variables



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Permitted Objects

- **WASD supports**
 - Tables, Views, and Indexes
 - Multiple schemas supported
 - Includes constraints, collations, computed columns
 - Sprocs, Functions, DML Triggers (in T-SQL)
 - Including recursive triggers
 - Logins (deployed to master), Users, DB Roles
 - User-defined Table Types
 - Includes UDDT
 - System SQLCLR UDTs - Spatial and HierarchyID
 - Linked Servers to WASD from SQL Server
 - No linked server to WASD master database



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Unavailable Functionality

- **Currently unavailable in Azure environment**

- Encryption Keys and Functions
- Auditing
- Event Notifications and SQL Agent
- Linked Servers from WASD
- Change Data Capture and Change Tracking
- XML Schema Collections and XML Indexes
- SQLCLR
 - Except for system SQLCLR types
- Service Broker
- Full-text search



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WASD and DBA Tasks

- **DBAs cannot control many database tuning/operational knobs**

- Instance-level options
- Database-level options
 - Only option: ALTER DATABASE TEST SET RECURSIVE_TRIGGERS ON;
- Disk placement
- Filegroups
- Replication - use synchronization (later)
- Log Shipping
- Resource governor
- Trace flags
- Note: ROW/PAGE Compression is supported



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WASD Backup and Restore

- **Traditional backup and restore not supported**
 - Import-export data using BACPAC
 - Import-export schema through DACPAC
 - Can use BCP, other tools
 - Point-in-time restore service available (Premium Database only)
- **Can create a transactionally consistent copy**
 - On the same or different server
 - CREATE DATABASE ... AS COPY OF ...
 - sys.dm_database_copies tracks these
- **Can set database up for continuous export (to BACPAC)**
- **Commercial products**



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Automated Export

- **You can set up automated export (on portal, preview)**
- **Specify**
 - Storage account
 - Start date
 - Frequency
 - Retention
 - Server login info
- **You can create a database from any of your automated export BACPACs**



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Maintenance For Performance

- **Index maintenance**
 - Index rebuild is supported (online and offline)
 - Index reorg is not supported
- **Auto-statistics enabled**
 - Auto-stats create, update
 - Cannot be changed with ALTER DATABASE
 - Use sp_autostats on statistics objects
- **All statistics update operations supported**
 - UPDATE STATISTICS
 - sp_updatestats
 - sp_autostats
 - DBCC SHOW_STATISTICS



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SQL Agent

- **SQL Agent is unavailable**
 - No MSDB database
- **You can**
 - Use Windows Azure Scheduler service
 - Create a Windows Azure Worker role
 - Write custom code
- **Commercial Tools**
 - Azure scheduler and notifications
 - <http://www.cotega.com>



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Troubleshooting

- **Connection and SQL Log views (in master)**
 - `sys.database_connection_stats`
 - `sys.event_log`
 - Includes deadlock messages, succeeded/failed logins
 - Additional metrics can be configured on portal (including throttled connections)
- **Query plans available (SSMS and Portal)**
- **Subset of DMVs available**
 - Transactions
 - Performance
 - `sys.dm_exec_query_stats` and others
 - `sys.dm_db_wait_stats`
 - Index DMVs
- **No SQL Profiler or XEvents yet**
- **Enhance traditional troubleshooting with application logging**



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Troubleshooting Throttling

- **You can watch for throttling in wait stats**
- **Watch for wait types in `sys.dm_exec_requests`**
 - `SE_REPL_SLOW_SECONDARY_THROTTLE`
 - `SE_REPLY_COMMIT_ACK`
- **Throttling messages in `sys.event_log`**
 - Throttling event type
 - Throttling_long_transaction event type
 - Check event subtype description



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Instance Patching and Versioning

- **WASD Database has it's own upgrade strategy**
 - Functionality additions happen over time
 - Rolling upgrade
 - Changes are "always" backward-compatible
 - `sys.dm_db_objects_impacted_on_version_change`
- **At time of this presentation**
 - Current is WASD February 2014
 - Announcements on:
 - <http://blogs.msdn.com/b/windowsazure>



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Version and Features

- **Does not correspond to any SQL Server "box" version**
 - `@@version` yields 11.0.xxxx.yy
- **Base T-SQL is currently at 2012 minus**
 - No sequences, windowing functions
 - Most SQL Server 2012-specific spatial features included
 - But not all of them
- **Some metadata contains SQL Server 2014-specific columns**



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Tracking Usage

- **WASD can produce separate network charges**
 - No charges for ingress
 - Charges for egress (US and Europe)
- **Track usage through DMVs in master**
 - sys.bandwidth_usage
 - sys.database_usage
 - sys.databases
 - sys.resource_stats
 - sys.resource_usage
- **Tracking features on Azure Portal**



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Azure Health Service

- **Part of Windows Azure, not WASD**
 - <http://www.microsoft.com/windowsazure/support/status/servicedashboard.aspx>
- **Tracks**
 - Current Status – Per Data Center and Service
 - Status History – For last five weeks



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Summary

- **WASD is a cloud-based version of SQL Server**
 - Managed by Microsoft, includes SLA
 - Topology is opaque to users and admins
- **Master is the only system database**
- **Uses TCP and gateway for connections**
- **Some SQL Server functionality currently unsupported**
- **Uptime and usage can be tracked**
- **Resource reservation can be created using "premium database" feature**



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Windows Azure SQL Database From A To Z Database Development

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Overview

- **Connecting to the database**
 - Supported APIs
 - Keeping your connection alive
 - Connection retry on failure
- **Dealing with resource throttling**
 - Decoding Reason Codes
- **T-SQL Differences**
- **Handling Transactions**
- **Federations**



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Application Styles

- **Code Far**
 - WASD in Cloud
 - Application Code on Premises or different Windows Azure data center
- **Code Near**
 - WASD and Application in same Windows Azure data center
- **Code Near Helps With**
 - Network Latency
 - Azure Data Transfer Charges



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Code Far and Programming

- **With "Code Far" model**
 - Minimize round trips to server
 - Minimize payload in each trip
- **Prefer table-valued parameters to**
 - One round trip for each operation
 - Large SQL batch
- **Be careful with Entity Framework and lazy loading**



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Database APIs supported

- **SQL Azure Database supports**
 - ADO.NET (3.5 and above)
 - ODBC (10.0 and above)
 - PHP (Microsoft Driver 1.1)
 - JDBC (Microsoft Driver 3.0 and above)
- **Frameworks Supported**
 - WCF Data Services (ODATA)
 - Entity Framework (.NET 3.5 SP1 and above)
 - Node.js
- **OLE DB not specifically supported**
 - But some apps that use it (e.g. SQLCMD) work
- **MARS supported**



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Network Data Encryption

- **All communications between SQL Azure and applications require encryption (SSL)**
- **Certificate from server should be validated**
 - To prevent man in the middle attacks
 - With ADO.NET, use Encrypt=True and TrustServerCertificate=False in connection string
 - Equivalent options in other APIs
 - Use -N option with SQLCMD



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Connection Best Practices

- **Use Connection Pooling**
 - Open late, close early
- **Handle idle and transient disconnect**
- **Try to reconnect in 10 second increments**
 - Back off reconnect interval over time
- **Trace Connections**
 - With CONTEXT_INFO
- **Use app-level caching**
- **Connect to closest server**



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Connection Pooling and SQL Azure

- **You can get a "dead" connection from connection pool**
 - SqlConnection.Open succeeds
 - Gets connection from pool
 - Executing a SqlCommand fails
 - A transport-level error has occurred when sending the request to the server.
(provider: TCP Provider, error: 0 - An established connection was aborted by the software in your host machine.)
- **Apply .NET 4 Reliability Update 1**
 - <http://support.microsoft.com/kb/2533523>
 - Does not substitute for connection retry logic



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Connection Strings

- **Connection Strings can be**
 - Hardcoded
 - Built With SqlConnectionStringBuilder
- **Certificate parameters for login**
 - Encrypt = true and Trust Server Certificate = false
 - To prevent man in the middle attacks
- **Passwords in code should be encrypted**
 - Use Windows Azure Certificates to encrypt in applications
 - Or client-specific configuration file encryption



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Programming with Retry

- **Connections can be lost because of**
 - Server Unavailable
 - DOS Attacks
 - Network Problems
 - Failover
 - Global Resource Limits (Connection-loss errors)
 - Database Size
 - Transaction log, lock use
 - Tempdb use
 - Others
 - Premium database can reserve some of these resources
 - Session Throttling – error 40501
 - Throttling Sleep Interval – 10 seconds



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Reasons For Connection Loss

- **Resource consumption**
- **Exceeding resource limits**
 - Global (non-premium database)
 - Reserved (premium database)
- **Idle connections**
- **Failover**



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Resource Limits

Resource	Limit	Error code
Database Size	150 GB or less depending on the database quota (MAXSIZE)	40544
Transaction Duration	State 1: 24 hours State 2: 20 seconds if a transaction locks a resource required by an underlying system task	40549
Transaction Lock Count	1 million locks per transaction	40550
Tempdb	State 1: 5 GB of tempdb space State 2: 2 GB per transaction in tempdb State 3: 20% of total log space in tempdb	40551
Transaction Log Length	State 1: 2 GB per transaction State 2: 20% of total log space	40552
Memory Usage	16 MB memory grant for more than 20 seconds	40553



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Throttling

- **Individual sessions can be throttled - returns error 40501**
- **Reason codes give more info**
 - The service is currently busy. Retry the request after 10 seconds. Code: %d.
- **Resource Type gives resource type, e.g.**
 - Physical Disk Space
 - Physical Log Space
 - CPU
- **Throttling Mode gives rejected statements**
 - No throttling
 - Reject Update / Insert
 - Reject All Writes
 - Reject All



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Connection Retry On Failure

- **Provided in ODBC, ADO.NET, and JDBC**
- **ODBC Driver - SQL Native Client 11**
 - Retry count and retry interval
- **JDBC Driver 4.0**
 - Set keep-alive and retransmission in registry
- **Connection resilience and transaction retry provided in ADO.NET 4.5.1**
 - And Entity Framework 6.0
 - CONTEXT_INFO surfaced as ClientConnectionId property
- **ADO.NET Transient Fault Handling Application Block**
 - Part of Enterprise Library 5.0 Integration Pack for Windows Azure
 - Includes declarative fault-handling rules for count and interval
 - Includable in projects (search for "Topaz" on NuGet within VS)
 - Special considerations for Entity Framework



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Noisy Neighbors

- **WASD databases are shared**
 - At instance (and database) level
- **Other users can affect your response**
 - Overall throttling
 - Resource consumption
 - Single shared CPU is default (MAXDOP = 1)
- **WASD premium services ameliorate this**
 - Dedicated CPU(s)
 - Dedicated Databases



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Moving to a Standalone Database

- **Model/test your migration using Contained Databases**
- **Meant to separate application (in-database) and system (in instance) objects and settings**
 - Makes databases more portable
- **Introduced in SQL Server 2012**
 - Partially contained databases
 - Database-level authorization
 - Standard collation handling
 - DMV and XEvents point out uncontained usage
 - Watch these when deciding if existing DB is a good fit for WASD
- **WASD databases are not contained databases**
 - No database-level authorization



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Programming Best Practices

- **Asynchronous programming and queuing help**
- **Add logging to your application**
 - Use CONTEXT_INFO to track to connection
- **Must be deliberate about number of round trips**
 - Table-valued parameters help
- **Break application into multiple databases**
 - But no distributed transactions
- **Eschew object-relational mappers**
- **Make sure you have a versioning strategy**
 - Must take application offline, can't take database offline



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CONTEXT_INFO

- **A GUID used to identify your connection**
 - Use with problem reports
- **For best results**
 - Connect
 - Immediate fetch context_info
 - Execute batch
 - Disconnect



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SQL Azure Stricter Requirements - 1

- **All "outside-database" functionality restricted**

- Filestream
- Distributed Transactions
- Many session set options
- Global temp tables
- Resource governor
- Trace flags
- Linked Servers
 - Linked Servers TO Azure only



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SQL Azure Stricter Requirements - 2

- **Additional restrictions and behaviors**

- No Heap Tables (create works, insert fails)
 - Except Temp Tables (#table only)
- Some deprecated T-SQL statements
 - COMPUTE BY
- No SELECT INTO
 - Use INSERT-SELECT - creates a heap
- Extended Properties
- RCSI is the default



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Feature Differences

- **Not all SQL Server features are available**
 - SQLCLR (system SQLCLR functionality available)
 - Full-text and semantic search
 - Service Broker
 - XML Schema Collections and XML Indexes
 - Change Data Capture and Change Tracking
- **Some of these may be added in future**



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SQL 2012 Features in SQL Azure

- **SQL Server 2012 Spatial Library**
 - Same library as in SQL Server 2012 CTP3
 - Subset of the new functionality is available
- **T-SQL features**
 - ORDER BY clause with OFFSET and FETCH
 - THROW statement for error handling
 - Metadata discovery
 - EXECUTE ... WITH RESULT SETS
 - Extended FORCESEEK, FORCESCAN query hints



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Using DDL from clients

- **Some command are executed in gateway**
 - CREATE/ALTER/DROP DATABASE
 - CREATE/ALTER/DROP LOGIN
 - CREATE/ALTER/DROP USER
 - USE FEDERATION
- **These must be the only command in batch**
- **Cannot be executed through dynamic SQL**
 - i.e. T-SQL EXECUTE

Hints

- **SQL Azure Supports**
 - Query Hints
 - Table Hints
 - Join Hints
- **PAGELOCK Table Hint Unsupported**
- **Doesn't honor/use MAXDOP hint**
 - MAXDOP is always 1

Transaction Isolation Levels

- **Default transaction isolation level**
 - Read Committed Snapshot Isolation
- **Other isolation levels available**
 - Including Snapshot



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Using Transactions

- **You can code with**
 - T-SQL Transaction Verbs
 - Database Transaction APIs
 - ADO.NET SqlTransaction
 - System.Transactions
 - Be careful - may escalate to distributed transaction
- **Transactions spanning databases not allowed**
 - Error Message 40014
- **Distributed Transactions Not Available**



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Alternative Data Storage

- **Windows Azure Storage**
 - Key-Value storage
 - NoSQL-like
- **Windows Azure Blob Storage**
 - Useful for staging blobs while loading
 - Useful with SQL "blob locators"
- **Hadoop on Windows Azure**
 - For data warehouse, not designed for OLTP
 - Import-Export HDFS and SQL Server using Sqoop
 - WASD can be used for Hive/Oozie metadata storage



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WASD and Scale Out

- **Maximum WASD database size is 150 gb**
- **Applications and WASD are scaled out, not scaled up**
 - No communication between multiple WASD databases on same server
- **This is accomplished by sharding**
 - Build you own sharding system (AzureCAT articles and upcoming code)
 - Windows Azure Federations are built-in
 - Third party products available



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WASD Federations

- **Federations are designed for:**
- **Elastic Scale**
 - Scale out when you need it
 - Scale back when you don't
- **Unlimited Scalability**
 - Horizontal Scaling To Many Nodes
- **Simplified Multi-Tenancy**
 - One or many nodes per tenant



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Related Terms and Technologies

- **Federation related to**
 - Partitioning
 - Scale out in SQL Server filegroups
 - Data-Dependent Routing
 - Scale out across databases based on smart middle tier
 - NoSQL
 - Parallel queries possible
 - Map-Reduce patterns
 - But...uses SQL within each federation member



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Federations – Definitions

- **Federation**
 - A database object within a database
 - There can be multiple federations in a database
- **Federation Root**
 - The database that contains the federation database object is known as the federation root
 - Member metadata is stored in the federation root
 - Applications connect to the federation root
- **Federation Key**
 - Each federation has a single key for partitioning data
- **Atomic Unit**
 - All the data for a value of a federation key
 - Stored in same shard/Federation Member



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Designing For Federations

- **Design is more denormalized than usual**
- **Three main types of tables**
 - Entity Tables
 - Subset in each federation member
 - Must use entity key – FEDERATED ON clause
 - Sharded by entity key – must be part of primary key
 - Reference Tables
 - Exist in each federation member in entity
 - Global (Central) Tables
 - Exist in federation root



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Creating the Federation

- **Create the federation root database**
 - **Connect to the federation root**
 - **Create the federation, specify**
 - Federation name
 - Federation key name
 - Federation key data type
 - Int, bigint, uniqueidentifier, or varbinary
 - Distribution type
 - Currently only RANGE is supported
- `CREATE FEDERATION`
`CustomerFederation WITH (cid bigint RANGE)`



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Programming Federations

- **Connect to Federation Root**
- **Issue 'USE FEDERATION' statement**
 - Includes Federation Name and Key value
 - FILTERING option
 - OFF – can see all atomic units in federation
 - ON – can use only key value atomic unit
 - WITH CONNECTION RESET
 - Required for now



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Creating Federated Tables

- **Connect to the federation root**
- **Issue USE FEDERATION statement**
 - Any key
 - Filtering = OFF
- **Create table with FEDERATED ON clause**
 - Federation key must be part of primary key

```
CREATE TABLE [dbo].[Customer](  
    [CustomerID] [bigint] NOT NULL,  
    ... other columns  
    CONSTRAINT [PK_Customer] PRIMARY KEY  
        CLUSTERED ([CustomerID] ASC)  
    ) FEDERATED ON (cid = CustomerID)
```



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Programming Differences

- **Joins, grouping, aggregation must be application managed**
 - No automatic "fan out" queries yet
- **Can't use distributed transactions w/members**
 - Disallowed in SQL Azure
- **Assigning a federation key is application managed**
 - Identity disallowed on all federated tables
 - Identity, timestamp allowed on reference tables
- **Federation keys are immutable**
 - Updates must be managed as delete/insert



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Using Fan-Out With ADO.NET

- **Fan out can be accomplished with DataSets**
- **Map Step**
 - Iterate through federation members using `sys.federation_member_distributions` until `high_value` is NULL
 - Fill the DataSet table with each set of values
- **Reduce Step (optional)**
 - For aggregation across members
 - Use
 - LINQ to DataSet
 - `DataColumn.Expression`
 - `DataTable.Compute`



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Federations and Entity Framework

- **Entity Framework is not federation-aware**
- **Some limitations/caveats**
 - Issue the `USE FEDERATION` statement manually
 - Using `ObjectContext.Connection`
 - Cast `DbContext` to `ObjectContext` in CodeFirst
 - Leave connection open
 - Cannot create database with code-first
 - MARS is not supported with federations
 - MARS used by
 - Lazy loading
 - `LoadProperty()` to explicitly load related objects as specified by navigation properties
 - `Load()` to explicitly load a collection of related objects



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Managing Federations

- **Federations support re-partitioning on-the-fly**
- **Managed using ALTER FEDERATION**
 - SPLIT expands number of members
 - DROP contracts members
- **Monitor with**
 - sys.dm_federation_operations
 - sys.dm_federation_operation_errors
 - sys.dm_federation_operation_error_members



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Utilities

- **Windows Azure portal supports**
 - All federation operations through GUI
 - Monitoring space used in federation members
- **SQL Azure Federation Migration Wizard**
 - Supports copy into federation members
- **Azure Federations support**
 - Sync services among shards
- **Federations not currently supported by**
 - Azure Import-Export
 - SQL Server Data Tools



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Federation Catalog Views

- **sys.federations** - Federation metadata
- **sys.federation_members**
- **sys.federation_member_distributions**
- **sys.federation_history**
- **sys.federation_distribution_history**
- **sys.federation_member_history**
- **sys.federation_member_distribution_history**



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Additional Services

- **Windows Azure Services w/WASD**
 - AppFabric Cache – can be used with SQL Server
 - DataMarket
 - Purchase data/subscriptions
 - ODATA interface
- **Database can be tied to application as a linked resource**
 - Connection strings still required
- **SQL Azure Labs**
 - Prototypes of related products/features



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Summary

- **Development similar to SQL Server but...**
 - Need to consider code placement
 - Must deal with re-establishing connections
 - Must be aware of load throttling
- **T-SQL support is different**
 - Subset of T-SQL and objects
 - Not all language options available
- **Transactions are different**
 - RCSI is default isolation level
 - No inter-database or inter-server transactions
- **Additional services available**
 - Synergy with other Windows Azure services
- **Supports federations**
 - For large-scale and multi-tenant apps



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SQLIntersection POSTCON02

Windows Azure SQL Database From A To Z Deployment And Synchronization

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Overview

- **Provisioning and Import-Export**
 - Scripts
 - BCP
 - SSIS
 - SQL Azure Migration Wizard
- **Development and Deployment using DACPAC**
- **Synchronization**
 - Windows Azure SQL Data Sync
 - Sync Framework SDK



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Deployment in SQL Azure

- **Deployment consists of**
 - Create database objects with DDL
 - Objects in specific database
 - Logins in master database
 - Populate Tables With
 - T-SQL scripts, BCP, SSIS
- **SQL Azure Migration Wizard (CodePlex)**
- **DACPAC and BACPAC-based deployment**
- **Migration Assistant for Access, MySql**
 - Supports WASD



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Using SQL Scripts

- **SQL Server 2008 R2 & above Scripter**
 - Option in SSMS or SMO
 - Choose Windows Azure SQL Database as target
 - Script Data option to generate inserts
- **Doesn't cover all WASD diffs**
 - Likely need to edit generated scripts
 - Add GO to batch inserts



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Using BCP

- **BCP is a low overhead, command-line tool**
 - Must provision schema separately
 - Be careful with connection parameters
- **For best performance**
 - Use native mode
 - Non-Unicode if possible
 - Character mode may be needed for interoperability
 - Use batchsize, first/last to control transaction size
 - Order by clustering key to optimize writes



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Using SSIS

- **SSIS is most programmable**
 - Use data flow with WASD
- **Use ADO.NET source/target**
 - OLE DB source/target not fully functional
- No WASD compatibility checks
- No WASD support for
 - Import-Export Wizard
 - Generates Schema without clustering key
 - Transfer SQL Server Objects
 - Problems with schema creation
 - Control flow task



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SQL Azure Migration Wizard

- **CodePlex Project**
 - Not Microsoft Supported
- **Configuration file**
 - Allows reconfiguration when supported types and objects change
- **Uses BCP to load**
 - Batched for faster, more robust load
- **Auto-creation of clustered index**
 - Prevent errors when heap tables migrated
- **Log file and window**
 - For troubleshooting
- **API available**
- **Supports Federations (separate tool)**



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Data-Tier Applications

- **A database schema deployment and versioning mechanism**
- **Supported by**
 - SQL Server Data Tools
 - SSMS 2008 R2+
 - Can be used with earlier versions of SQL Server (back to SQL Server 2005)
 - Windows Azure PowerShell cmdlets
 - Windows Azure Portal
- **Deployment Information in zip file**
 - DACPAC



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First, Some Terms

- **DAC**
 - Encompasses all other names and concepts
- **DACFx**
 - The DAC Framework, DLLs
- **DACPAC**
 - The file format used by DACFx that contains the full declarative definition of a database schema. Best analogy: an MSI.
- **BACPAC**
 - The file format used by DACFx to contain the definition of an application/database schema as well as its (table) data.



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What Does It Do?

- **SQL Server Data Tools/DACFx features include:**
 - Building a DACPAC from a set of T-SQL scripts
 - Extracting a DACPAC from a database
 - Deploying a DACPAC to a new database
 - Incrementally upgrading an existing database schema via DACPAC
 - Exporting a BACPAC from an existing database
 - Importing a BACPAC to a new/empty database
 - Schema comparison
 - Online Database Development Tools



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What Problem Does It Solve?

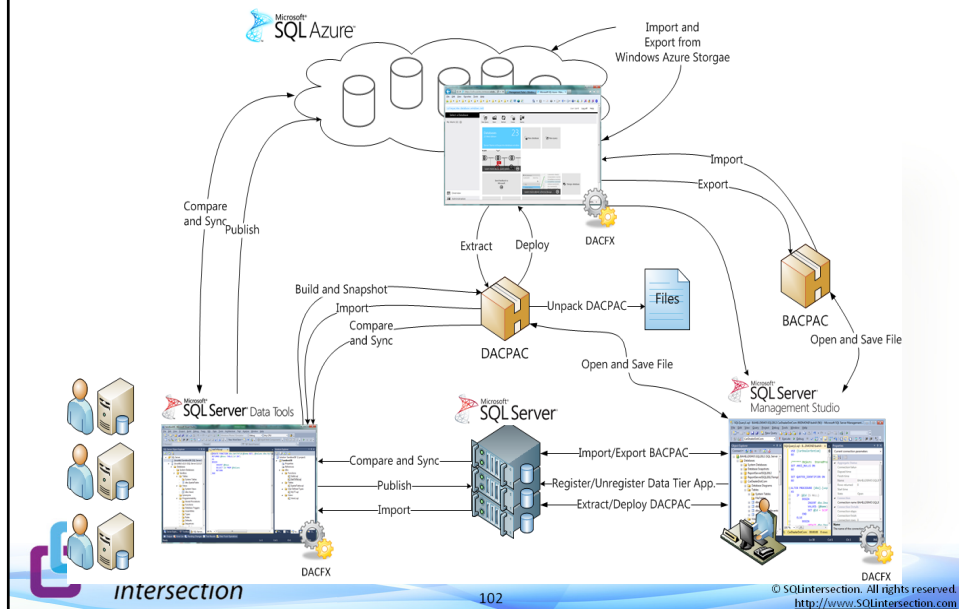
- **Meant to simplify deployment across**
 - SQL Server release/version differences
 - Features, T-SQL dialect
 - WASD vs. SQL Server
 - T-SQL dialect, other differences
 - Others...
- **Migrating database between instances**
 - On Premises => WASD and back
 - Or between On Premises
- **Replacement for Backup and Restore**
 - Across version-incompatible instances
 - Not point-in-time recovery



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DAC Scenarios



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Working with DACs

- **Data Tier Application can be deployed**
 - Deployment in SSMS 2008 R2+
 - Be careful of DAC infrastructure version in earlier SSMS releases
 - From SSDT and SqlPackage command line tool
 - Register Existing Database as DAC
- **DAC history tracked in Master for WASD**
 - In SQL Server, history is tracked in MSDB



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DAC Features

- **DAC supports portable schema**
- **DAC includes portable data**
 - Extract data to BACPAC
 - Deploy Schema and Data on other server
- **All database objects supported by SQL Azure are supported in DAC**
- **Includes Import-Export API and Service**
 - Public service to export->BACPAC->import
 - BACPAC on Windows Azure storage
 - Works with SQL Server too
- **Nov 2012 update improves WASD deployment**



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SQL Server Data Tools

- **Developer ALM tools for SQL Server**
 - Free download
- **Works with SQL Server 2005-2012, WASD**
- **WASD-specific T-SQL code editing**
- **SqlPackage Command Line Utility**
 - Also available on SQL Server 2012 Feature Pack



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DACFx 3.0 in SSMS 2012

- **On SQL Server or SQL Azure node in Object Explorer**
- **Databases Folder**
 - Deploy (from DACPAC)
 - Import (from BACPAC)
 - Local file system or Windows Azure storage
- **Individual Databases/Tasks**
 - Extract
 - Migrate Database to Azure (using BACPAC)
 - Export (to BACPAC)
 - Local file system or Windows Azure storage
 - Register
 - Upgrade
 - Delete (Unregister)



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Migration Assistants

- **SSMA supports migration from**
 - Access (97 and later)
 - MySQL (V 4.1 and later)
- **Supports WASD target**



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Sync Services

- **Sync Framework supports sync between**
 - SQL Server to WASD
 - WASD to WASD
 - WASD to SQL Server
 - Other database and other data
- **Current version is 4.0**
- **Unidirectional or bidirectional sync**
 - Uses hub and spoke architecture
- **Optional conflict resolution (custom and auto)**
- **Filters**
 - Database includes row and column filters
- **Metadata Model encapsulates**
 - Data store, Data type, Protocol, Network config
- **Logging and statistics**



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Providers

- **Sync Services uses Providers**
 - Database Providers for
 - SQL Server (includes WASD)
 - SQL Server CE
 - Custom
- **Provider implementation changes in 2.1**
 - WASD support
 - Bulk application of changes
 - Parameter-based filtering
 - Scope, template removal
 - New metadata format (not compatible with older format)



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Sync Services - Scopes

- **Uses scopes to group sets of tables**
- **Scopes are groups of tables**
 - Synchronized as a single unit
 - Can be used as unit of provisioning



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Sync Services - Provisioning

- **Change tracking via triggers**
 - Use tracking tables
 - No change to user tables
- **Uses stored procedures and meta-data tables**
 - Does not use Change Tracking (in 2.1) or CDC
- **Snapshot isolation enabled**
 - Requirement for SQL Server database
 - Always enabled on WASD



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Windows Azure SQL Data Sync

- **New cloud-based service (currently preview)**
 - Built on Sync Services and Windows Azure
 - Uses Windows Azure Blobs
- **Declarative customization**
 - Setup and monitoring through portal
- **Uses scopes**
 - Transactions can split into batches
 - Batches can be applied in transactions on target
 - Referential integrity ordering preserved
 - Transactions on source not preserved
- **Rich subset of 2.1 options implemented**



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Summary

- **A choice of tools for**
 - Provisioning WASD metadata
 - Provisioning WASD data
 - Migrating SQL Server and other databases
- **SSDT & DAC provide enhanced WASD support**
- **Sync Services 2.1 API supports keeping sets of tables synchronized**
 - Windows Azure SQL Data Sync is portal-only implementation based on the APIs



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Windows Azure SQL Database From A To Z

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Thank you!